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POSSIBILITY OF FINDING GAS IN THE ORISKANY SAND IN McKEAN COUNTY

By

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INTRODUCTION

McKean is the principal oil-producing county of Pennsylvania, most of its production coming from the world famous Bradford Field in the north central part of the county. In the southeastern half, and in the extreme southwest part of the county, natural gas is the principal product. All of the oil and gas production of the county has come from the so-called "shallow" sands (Speechley to Elk). Discovery of most fields was made in the period 1864-1880.

The principal oil-producing sand, the Bradford, has responded so well to recovery by the water-flood method, that many years of oil-producing life are conceded for the Bradford Field. The gas fields have no such assured future, wells commonly are small, rock pressures low, and there is little assurance that new "shallow" sand fields will be found.

In 1930 gas was discovered in the Oriskany sand, a "deep" sand of this region, in Tioga County*, and in 1931 in adjacent Potter County**. These discoveries have led to the development of two attractive fields in which well volumes average about 15 million cubic feet initial a day, and initial rock pressure ranges between 1450 and 2200 pounds per square inch. This paper is concerned principally with the possibility of finding gas in the Oriskany sand in McKean County. Experience up to now has shown that accumulation of gas in the Oriskany sand is closely related to structurally high points or domes, on antiolines. The structure map, Fig. 1, is therefore our principal contribution.

The map, Fig. 1. Includes data from two sources. Structure in the Bradford district is shown by 50-foot contours drawn on the Bradford sand. They were determined by C. R. Fettke and are based upon a detailed study*** made by Mr. Fettke for the Pennsylvania Geological Survey. The Smethport, Hebron, and Harrison anticlines were traced in a reconnaissance way by M. N. Shaffner and the writer in 1932. The absence of readily recognized horizon markers and the lack of time, funds, and topographic base maps dictated the use of the strike and dip method in mapping. Admittedly the results of our reconnaissance survey are not satisfactory in this area; folds are gentle, exposures too few, mediocre in quality and unequal in distribution. In the western edge of the county, the structure has not been determined as it was felt that in mapping the Smethport anticline the strike and dip method was being extended to the limit of its usefulness. To the north and west of the Smethport the prevailing structure is the warped surface which demands detailed study for its solution.

Prospects of obtaining gas from the Oriskany sand

We believe that the chances of finding gas in the Oriskany sand in this county are excellent wherever (1) the sand is present, (2) the sand is capable of containing gas, that is, is sufficiently porous and (3) wherever structural conditions are favorable to its accumulation.

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*Described in Pennsylvania Geol. Survey, Bull. 107, February 1, 1934.

**Described in Pennsylvania Geol. Survey, Bull. 106, February 1, 1934.

***The results of Mr. Fettke's study of the Bradford District are being prepared for publication as an Atlas of the Pennsylvania Geological Survey. In view of the comprehensive discussion that this publication will make available, no attempt is made to summarize the oil and gas situation of the county in this paper.

A discussion of the shallow oil and gas sands of the county including graphic sand correlation charts for townships is included in Pennsylvania Geological Survey Bull. M-19, 1933, Contributions to Oil and Gas Geology of Western Pennsylvania.

The third point should be emphasized, for in the principal oil and gas fields of western Pennsylvania there commonly is no apparent close relationship between accumulation of gas and structure highs*. However, all of the gas production of western Pennsylvania comes from the "shallow" sands. The habit of these sands is likely to differ materially from the habit of the Oriskany sand, and the same "rules" should not be applied to both. The "shallow" sands are very often lenticular, that is, the sand either grades into shale or loses its effective porosity. Such being the case the structural principle of accumulation when applied to them has a limited opportunity to be effective, for if a sand containing gas pinches out on the flank of a fold the gas can travel up the flank toward a dome only so far as the sand extends, no farther. As a result, in lenticular sand fields we may expect gas to accumulate in almost any relation to structural highs.

Compared with the "shallow sands" the Oriskany sand, when considered in a regional way, is a continuous affair and gas may be expected to accumulate in it where structural highs exist. Both the Tioga and Hebron fields are closely related to structural highs. First tests of the Oriskany should therefore be made in the best structural positions available, namely near the tops of domes on anticlines. If gas is present in the sand it should be found here.

That the Oriskany is "comparatively" continuous is said advisedly. Actually the sand is not everywhere present and locally even where present it may be so "tight", that is, lacking in effective porosity, that it cannot contain gas. An example of the sand dying out is afforded by the Haywood well, Hamlin Township. Further reference is made to this on a later page. Whether the sand is present and capable in any specific locality can be told only by the drill. The information obtained from one well is, moreover, not applicable to any considerable area, for the sand may disappear and reappear, lose and regain its capability, within a very short distance.

STRUCTURE**

General. Named from southeast to northwest the principal structural features that have been recognized in McKean County are as follows:

Harrison anticline	Smethport anticline
Norwich syncline	Ormsby syncline
(or 3d Bituminous basin)	Simpson anticline
Hebron anticline	Big Shanty syncline
Clermont syncline	Bradford anticline
(4th Bituminous basin)	

The folds in this area are gentle. The Smethport, Hebron and Harrison anticlines represent the most northwesterly members of a system of folds that follows the edge region of the Appalachian plateaus. Members of this system are notable for continuity, parallelism, and constancy of trend. Throughout the system folds commonly are asymmetric with slightly steepened southeast limbs and, in general, intensity of folding decreases from southeast to northwest.

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*Oil and Gas Fields Map of Western Pennsylvania, Pennsylvania Geol. Survey, 1933. Map on scale 1 inch = 6 miles. Shows oil fields, gas fields, structure contours or anticlinal axes in colors, and on back oil, gas, and gasoline pipe lines. Can be obtained from Bureau of Publications, Department of Property and Supplies, Harrisburg, 25 cents (stamps not accepted).

**The following papers are available on the adjacent region. Bull. 106, Potter Co.; 107, Tioga Co.; 108, Structure in the Plateaus Region of Northern Pennsylvania; 109, Cameron Co.; 110, Elk County. Issued by the Pennsylvania Geological Survey, 1934.

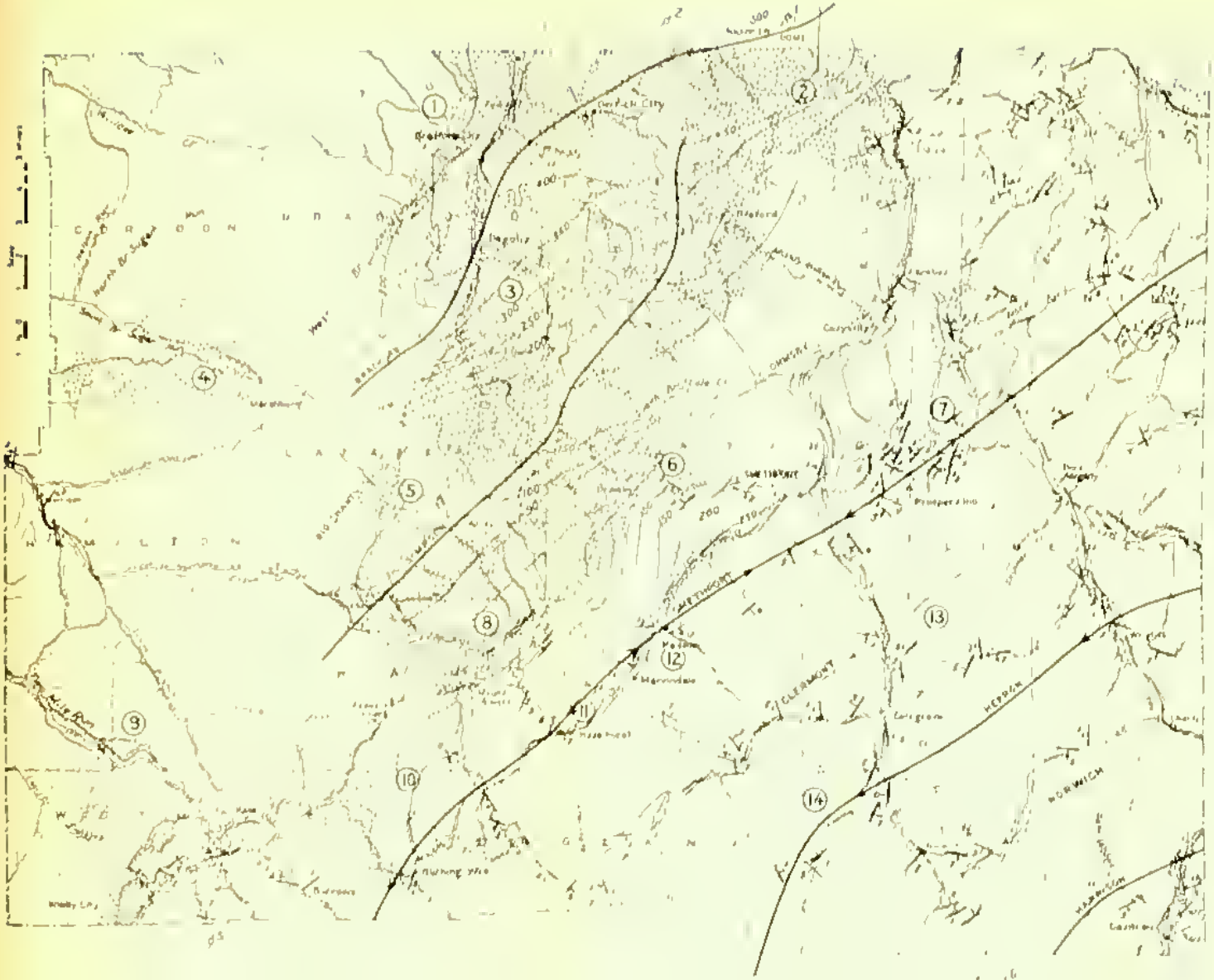

Fig 1

STRUCTURAL GEOLOGY
MC KEAN COUNTY

EXPLANATION

- Anticlinal axis and direction of plunge
- Synclinal axis and direction of plunge
- 1st 2nd 3rd 4th class dips
- Contours on Bradford sand
- Fault

Oil fields — Gas fields

1	Gilbert Run	8	Kushequa
2	Windfall	9	Wetmore
3	Bradford	10	Kane
4	Sugar Run	11	Hazelhurst
5	Lafayette	12	Marvindale
6	Ormsby	13	Colegrove
7	Smethport	14	Betula

Wells — Dry in Oriskany — Drilling

1	Quenlin	5	Kane
2	Ryder Scott	6	Emporium Bank No1
3	Derrick City	7	Emporium Bank No2
4	Haywood	8	Zerby

Northwest of the Smethport the warped surfaoe is the prevailing type of structure. Here the tendency toward parallelism, continuity, and constant trend are not notable features. Structures commonly are very gentle, lacking in uniformity, and are therefore traceable only by intensive geologic methods.

The Smethport and Hebron anticlines appear to be relatively simple, practically continuous folds, but they are quite gentle and do no doubt reflect to some extent the oharacteristics of the warped surface to which they are adjacent.

Harrison anticline. The axis of this fold cuts the southeast corner of the county, its length within the county being about 5 miles. The position of the axis is only approximately determined by data observed locally, but in adjacent Potter and Cameron counties the position is well fixed.

The structure in this county is believed to be part of a domed area that appears to extend from east of Sinnemahoning Portage in Potter County to west of North Run in Shippen Township, Cameron County. Chemung rocks are exposed on Sinnemahoning Portage and its tributaries in the vicinity of the axis and in a railroad cut at Gardeau Chemung beds show positive evidence of faulting. The fault here is something like $1\frac{1}{2}$ to 2 miles from the axis on the south flank of the fold. It was not observed elsewhere, but indications of its presence could no doubt be found if careful search were made.

This antioline appears to offer an exoellent opportunity for a test of the Oriskany in this region. Drilling should, however, be preceded by very oareful detailed study to insure proper position with respect to closure and to the fault.

Hebron anticline. Tho axis of this structure is fairly well fixed by data on Allegheny River in western Potter County, on Allegheny Portage Creek, and on Potato Creek, but between Potato Creek and a point well south of the Elk County line its position is poorly controlled. All of the structural data observed indicate southwest plunge, but the scarcity of these data does not permit the statement that north plunge is absent. The most we can say is that, in so far as we have observed, the axis does not seem to be domed in this county.

Smethport anticline. The Smethport anticline is the most westerly of the strongly defined folds in this region. As it borders closely upon the region where the warped surface rather than parallel folds of pronounced continuity is the rule it may be expected to be rather intermediate in character. The axis is shown here as a continuous smoothly curved line. Actually, strike and dip data are too few and of too poor quality to define accurately the details of the structure.

In general this anticline is broad and flat-topped and plunges gently southwest. Our data suggest doming in the vicinity of Marvindale and east of Smethport in the vicinity of Prospect Hill.

At Hazelhurst thore is definite southwest plunge of more than average intensity. At Kasson a south dip of 12 degrees is observed and east of Kasson there is indication of northeast plunge. It is probable that the axis plunges northeast in the vicinity of Kasson. The 12° south dip near Kasson suggests the possibility of faulting on the south flank.

The drillable area on the south limb of the dome probably is small as the result either of a fault condition or of steepened dip. North of the axis the beds appear to roll gently before making their final plunge into Ormsby syncline and as a result the drilling area here may have appreciable width.

In the vicinity of Prospect Hill strike and dip data are very poor, but when the country is viewed from Prospect Hill the course of the anticline is clearly indicated by physiographic data. Strikes and dips indicate a southwest plunge just southwest of Prospect Hill and northeast plunge a mile or so northoast of Prospect Hill.

Bradford region. Fettke's contours on the Bradford sand indicate that in the Bradford region there are two anticlines, the Simpson and the Bradford, and that they converge in Otto Township and form the Knapp Creek dome. Between them is the Big Shanty syncline. Between the Simpson and Smethport anticlines in southwest Keating Township is the Ormsby syncline and strike and dip data suggest that this feature may continue to the New York State line.

Structural summary. In resumé, our reconnaissance suggests the presence of a dome on Harrison anticline in southeastern Norwich Township, one on the Smethport anticline in the vicinity of Marvindale, and another east of Smethport. The data do not, however, serve to define the limits or the amount of closure on these structures, to do which will require detailed study. It should be emphasized that the Harrison dome is definitely faulted and that faulting may also be present at the Hazelhurst dome. In making well locations the effect of these south flank faults should be carefully weighed, a fact that has been amply demonstrated at Tioga and Hebron fields.

The domes we have mentioned are not the only possible structures existing in this area. The Smethport and perhaps also the Hebron anticlines have been referred to above as probably possessing some of the characteristics of the warped surface, that is, instead of being simple, narrow, elongated folds with essentially regular limbs and axis rising locally to form a dome, the limbs may be expected to show anticlinal noses and flattened areas or terraces; the axis may consist of echelon axes with area of slight closure. Structures of this sort might easily have escaped detection in our reconnaissance survey and if they exist they may prove productive. Their exploration, however, should follow the exploration of the more pronounced, better-defined structures.

Kinzua-Emporium cross anticline. With one exception all structure maps of McKean County previously published by the State Geological Survey have shown an anticline trending in a northwest direction, across the regional trend of folding. The axis of this cross fold was shown as entering southeast Sergeant Township and at tho northwest corner of Hamlin Township swinging west across central Hamilton Township. The axis extended from southern Cameron County into Warren County and was so placed by the Second Pennsylvania Geological Survey to connect a series of domes on anticlines and saddles in synclines, and thus to call attention to cross folding. Unfortunately the same convention was used for this as for all other structural axes and confusion resulted to those not acquainted with the text of the county reports. The axis is omitted on the map accompanying this report, as we feel that it does not accurately represent the situation. When the details of the structure in this region are known it is probable that cross alignment will be best represented by a number of short axes rather than by a single axis. What has been recorded as crossfolding may prove to be no more than radial adjustment such as might be expected in any extended system of arcuate folds*.

STRATIGRAPHY**

All of the rocks exposed in McKean County are sedimentary in origin, consisting principally of shales and sandstones with some conglomerate, limestone and coal. Their aggregate thickness is about 1,300 feet. The youngest exposed rocks belong to the Allegheny formation of Pennsylvanian age, the oldest to the Chemung formation of Devonian age.

The following is a summary statement of the stratigraphic information available to us:

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*Bull. 108.

**No comprehensive stratigraphic work has been done in this region since Ashburner mapped the county in 1879. The following brief outline is abstracted from Ashburner's Report vol. R of the Pennsylvania Second Survey, except where specific reference is made to some other source.

Rocks exposed in McKean County

Series	Formation	Thickness
Recent	Quaternary Alluvium	
Pleistocene	Glacial drift	
	Unconformity	
Pennsylvanian	Carboniferous Allegheny formation	0 - 140
	Pottsville formation	160 - 220
	Unconformity	
Mississippian	Mauch Chunk formation	0 - 10
	Pocono formation	250 - 325
Devonian	Catskill red beds	250 - 300
	Chemung formation	0 - 300±

Unexposed rocks

Record of Derrick City deep well*

	Thickness	Total
Chemung group	2,100	
Bradford sand (1,245 feet below top)		
Haskill (Smethport) sand 430 feet below Bradford		
Portage group	1,300	
Genesee black shale	175	
Hamilton group	490	
Onondaga limestone	70	4,135
Oriskany sandstone	20	
Helderberg limestone	60	
Cobleskill limestone	20	
Salina group	850	
Lockport dolomite	300	
Clinton group	175	5,560
Medina group	140	
White Medina 58 feet, Red Medina 82 feet		

This well began 125 feet below the top of Chemung and finished in Queenston red shale at 5,820 feet, 120 feet below the base of the Medina group.

*After Fettke, C. R., abstracted from Bulletin Geol. Soc. Am., vol. 44, pp. 620-621, 1933.

Record of Kane deep well*

	Thickness	Total
Chemung group	2,308	
Portage group	1,804	
Genesee black shale	63	
Tully limestone	6	
Hamilton group	440	
Onondaga limestone	82	4,703
Helderberg limestone	20	
Tonoloway limestone	130	
Camillus formation	912	
Pittsford shale	90	
Lockport dolomite	320	
Clinton group	176	6,351
Medina group	166	

The Chemung and Portage groups contain the most productive oil and gas sands of the county, the Oriskany sand produces gas in the recently discovered Hebron and Tioga fields of Potter and Tioga counties, and the Medina is a producing horizon in New York State.

Distribution of formations

McKean County is part of a dissected plateau. Something like 35 per cent of its area is rolling upland that ranges from 2,000 to 2,400 feet above sea level; the remainder is mostly valley slope, even the principal streams flowing through narrow flats. The principal valleys are 500 to 700 feet below the upland level.

Chemung and Catskill rocks appear at the surface only in certain valleys and the Coal Measures cap the highest hills. As the regional dip is southwest the older rocks are most widely exposed in the northeast part of the county and the youngest in the southwest part. Some of the detail of the distribution of the several formations is shown by Fig. 2 taken from the State Geologic Map** which in turn is a reproduction of a map made by the Second Pennsylvania Survey in 1879. No detailed geologic map of the county exists and only the Bradford District has been mapped topographically.

Description of formations

Allegheny formation. A maximum of 140 feet of this formation is preserved in McKean County. A generalized section is as follows:

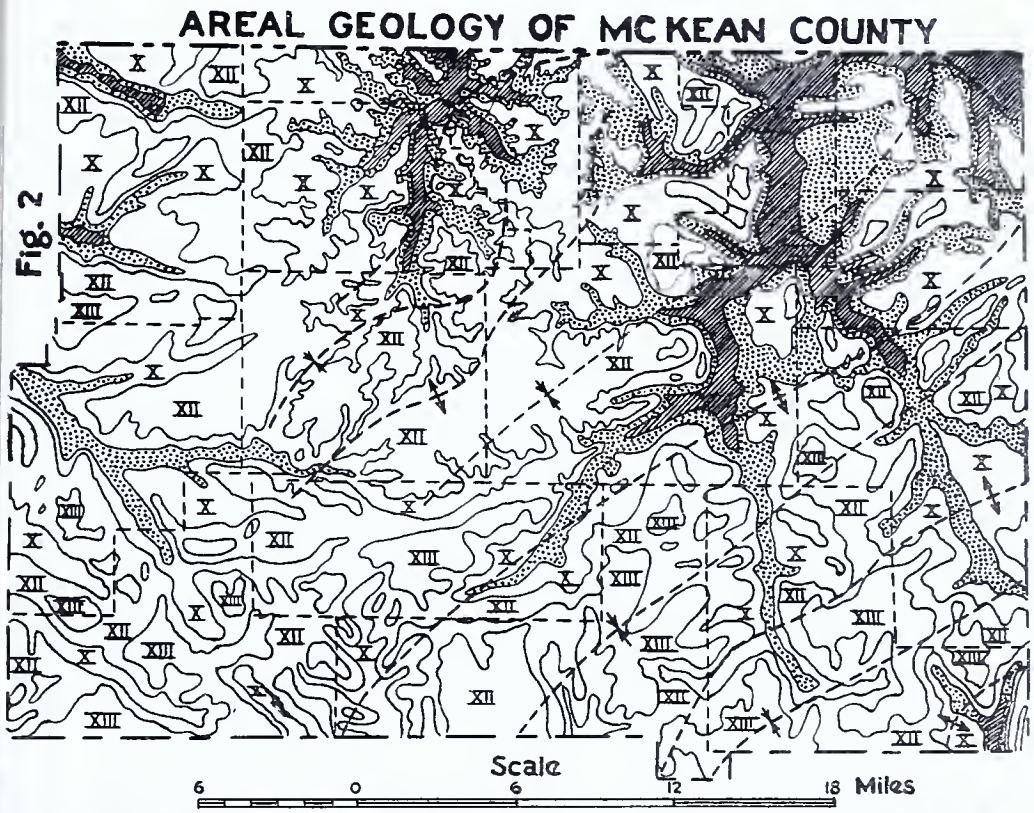
*Op. cit., p. 611.

**Issued by Pennsylvania Geol. Survey in 1932. Shows formations in color on scale 1 inch = 6 miles. Can be obtained from Bureau of Publications, Department of Property and Supplies, Harrisburg, for $1.50 (stamps not accepted).

	Feet
Gray and black slates	20
Coal, Middle Kittanning . . .	1
Gray and brown sandstone . .	40
Dagus coal, Lower Kittanning	2 - 3
Fire clay	2
Sandstone and slate	8 - 30

	Feet
Clermont (Ferriferous) limestone	4 - 8
Sandstone and slate . . .	30
Clermont coal (Clarion) .	3
Fire clay	3
	140

Fig. 2



The Middle Kittanning coal is present only in a small area at Clermont and is not workable. About 40 to 50 acres of the Dagus bed are preserved in the Clermont basin; it is present in the Norwich but not in the Alton basin. The Clermont coal is, of course, the most widely distributed.

Pottsville formation. The Pottsville formation consists of five members as follows:

	Feet
Johnson Run sandstone (Homewood).	30 - 75
Alton shales and coal (Mercer) .	20 - 35
Kinzua Creek sandstone (Connoquenessing sandstone)	45 - 60
Marshburg shale and coal	5 - 15
Olean conglomerate (Sharon) . . .	50±

In mapping McKean County the Alton coal-bearing member and the Johnson Run sandstone were included with the Allegheny shales and coals and mapped as the "Lower Productive Coal Measures". They are shown thus on Fig. 2.

The Johnson Run sandstone, the top member of the series, consists of rather massive, fine-grained, ferruginous sandstone containing frequent alternations of shale. In this district it is the most variable in thickness and character of any of the Pottsville members.

The Alton coals and shales. With the exception of very small areas of the Clermont and Dagus beds the Alton member includes all the coals of commercial value in this county. The member is composed principally of shale and fire clay and usually contains three distinct beds of coal known as the Alton Upper, Middle and Lower beds. At no locality in the county is more than one bed thick enough to be workable. The upper coal was mined at Buttsville, near Clermont and east of Norwich. Commonly it consisted of one bench and ranged from 2 to $3\frac{1}{2}$ feet thick. The middle coal is separated from the upper by 5 to 12 feet of fire clay, slate or shale, and commonly is in 2 to 4 benches separated by shale or fire clay. It has been mined at Lafayette and at Alton and ranged in thickness from 4 to 8 feet. It is known as "The" Alton bed. The lower coal with under clay lies immediately above the Kinzua Creek sandstone. It is well developed only in the eastern part of the county, being 4 feet thick in Norwich basin.

No limestone corresponding to the Mercer limestone has been recognized in the Alton group, but scatterod nodules of the iron carbonate that occur in some of the shale beds may represent the Mercer iron shales.

Kinzua Creek sandstone. In general character this rock is very similar to the Johnson Run sandstone and in many localities it bears a close resemblance to the Olean. It is less massive and ferruginous than the Johnson Run and has a less conglomeratic and homogeneous structure than the Olean. It breaks down more rapidly on weathering than either of the other sandstones and as a result seldom shows bold outcrops. The quartz grains of the Kinzua Creek are frequently whiter, more angular and are surrounded with less cement than in the other sandstones. It differs from the Johnson Run in containing a few pebbles and from the Olean in containing very much smaller and fewer pebbles. Its thickness is fairly constant at from 45 to 60 feet, although the outcrop of the rock commonly is in part concealed by debris from the overlying Johnson Run and Alton members. Shale beds frequently alternate with the sandstone and below the center of the member is a sporadic coal bed that may be equivalent to the Quakertown coal that lies between the Upper and Lower Connoquenessing sandstones.

Marshburg coal and shale. The coal is sporadic in occurrence but when found occurs in a shale and slate interval of 5 to 15 feet in thickness that separates the Kinzua Creek from the Olean. The coal has never been profitably mined.

The Olean conglomerate, usually consists of a loosely-cemented, white or gray conglomerate containing spheroidal pebbles ranging in size from a pea to a goose egg; or of a loosely-cemented, coarse-grained sandstone. The pebble beds are lenticular in form, varying both in extent and in thickness, but the entire thickness of the Olean is remarkably uniform. The sandstones lying between the conglomerate beds are cross-bedded. The grains of quartz forming the rock are less sharp and angular than in the Kinzua Creek sandstone.

The Olean conglomerate may be confused with the Sub Olean (Pocono) conglomerate which underlies it, but the two rocks can be differentiated as follows. The pebbles in the Olean are invariably round or egg-shaped, whereas the pebbles in the Sub Olean are oblate — having the shape of a flattened orange. The Sub Olean also tends to break into flags, is very ferruginous and contains iron and clay balls.

Mauch Chunk formation. Throughout central and northern McKean County the Mauch Chunk is represented by 5 to 10 feet of ferruginous clayey shale or black slate containing a thin slaty coal. A well in northern Elk County shows

45 feet of Mauch Chunk, 35 feet being red shale; in northern Cameron County the Mauch Chunk is 50 feet thick; in western Potter County about 30 feet. In McKean County the formation is thin and, lacking the distinguishing red color, may not be readily recognizable.

Pocono formation. The Pocono in northern and western McKean County includes a prominent conglomerate, the Sub Olean, which in the southeast part of the county cannot be distinguished. The following subdivisions of the Pocono are therefore applicable with limitations:

Upper shales and sandstones
Sub Olean conglomerate
Lower shales and sandstones

The upper shales and sandstones range in thickness from 50 feet in the northern part of the county to 90 feet at Kane and 230 feet at Ridgway, Elk County. They consist of gray and yellow flaggy sandstones and argillaceous shales.

The Sub Olean conglomerate (Knapp) consists of a conglomerate, a sandstone, or alternations of each. The conglomerate is composed of a ferruginous, open, angular, loosely-cemented sand, containing pebbles varying in size, color and composition, but almost always having the form of a flattened spheroid. The rock tends to break into layers varying from a few inches to 2 feet in thickness. The pebbles separate readily from the matrix and are hard, smooth, and compact, — much more so than the pebbles of the Olean. The sandstone is hard, massive, fine-grained, ferruginous, often contains iron balls and has a tendency to break into layers like the conglomerate. The sandstone may be quite shaly and locally alternates with the shale. The thickness of the Sub Olean averages about 40 feet.

Lower Pocono shales and sandstones. This member is very similar to the upper member, except that the sandstones are less massive, more flaggy, and the alternations of shale more frequent. The thickness varies from 150 feet at Bradford, to 190 feet in the vicinity of Kane. At Bear Creek and Ridgway, Elk County the thickness is 350 and 413 feet respectively. In the southeastern part of the county it is about 300 feet. Details of the thickening of Pocono rocks are shown on a later page.

Catskill red beds. The name Catskill as used here refers to a dominantly red series of sandstones and shales that for the most part are nonmarine in origin. They are widespread in Pennsylvania, vary greatly in thickness, and do not everywhere represent the same stratigraphic horizons. In the eastern part of the State they are 5,000 to 6,000 feet thick and the basal red beds are Portage in age; in central McKean County they are only 250 feet thick, and the lowest members are not older than upper Chemung*. The series in McKean County consists chiefly of red and gray shales and fine-grained gray sandstones. There is no sharp contact with the Chemung below, or with the Pocono above, the red beds disappearing gradually and the arbitrary boundary being drawn where red ceases to be dominant.

The characteristics of the red bed series as outlined, preclude its use as a horizon marker throughout any extended area. The color, however, permits of ready identification in the field and in well cuttings, and owing to the absence of other readily identified horizons the "base of the red beds" has been found by oil and gas men to be a very useful reference horizon if its use is restricted to small areas.

The Catskill red beds include the Venango oil sand group, but these sands are not productive in McKean County.

Chemung formation. The oldest rocks exposed in the county belong to the Chemung formation which is here divisible into three members: (1) Upper shales

*Willard, B., Bull. Geol. Soc. Am., vol. 44, pp. 495-516, 1933.

and sandstones, (2) Bradford oil sand, and (3) Lower shales and sandstones. Rocks of the first member only appear at the surface.

The upper member has an average thickness in McKean County of 1,300 feet. It can be subdivided into three parts, an upper gray, a middle red and gray, and a lower gray having average thicknesses of 350, 300, and 650 feet respectively. The upper portion consists chiefly of gray shale and sandstone. The amount of red in the middle portion is very variable, but seems to increase toward the south and east. The red is much duller and deeper than the red in the Catskill. The most persistent bands are near the top and are possibly equivalent to the Mansfield iron ore beds of Tioga County. The lower portion resembles the upper and includes the first and second of the Bradford sands.

The Bradford sand has been the most important economic stratum in the county. It consists of gray and white sand of about the same coarseness as ordinary beach sand; is compact, yet loosely cemented. The average thickness is about 45 feet. By comparison with the Venango sands and most other "shallow" sands of Pennsylvania, the Bradford is remarkably uniform, a quality that has permitted the development of secondary recovery methods in producing oil in the Bradford Field.

The lower member* has not been so extensively explored by the drill. So far as known it resembles the upper member. At Smethport it includes the Smethport sand 360 feet below the Bradford.

The thickness of rock formations in McKean County as given by Ashburner is shown in the following table:

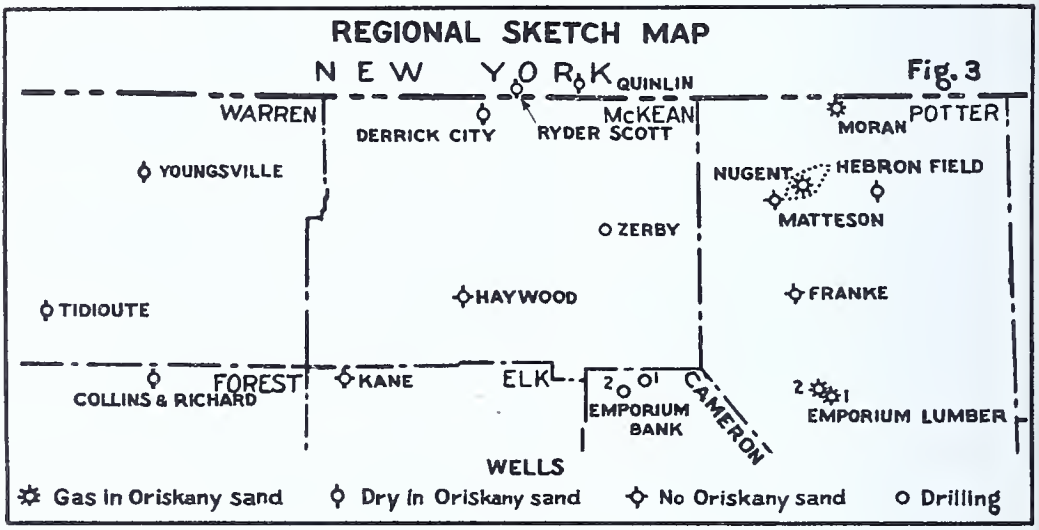
*The "lower member" is now recognized as Portage.

Thickness of formations in McKean County

Locality Township	Alle-gheny	Pottsville	Mauch Chunk	Pocono	Cat-skill	Chemung
unty omposite*	140	160	10	250 (Upper 60 (Sub Olean 40 (Lower 150	250	(Upper 1,300 (Bradford 45 (Lower 645+
adford*		145 (ss. 20 (Alton 25 (ss. 50 (coal - (cgl. 50	247		250	(Upper 1,300 (Bradford 35
res*				250+	250±	
nin*				250-300	300	
berty*		190	250-300		300	100+
ating*	15	185	260		250	(Upper 1,302 (Bradford 20 (Lower 664
milton*	96	220	350		260	(Upper 1,306 (Bradford 54
afayette*	47	202 (ss. 70 (Alton 24 (ss. 46 (coal 2 (Olean 60	0	160-250		
orwich Eastern Part	105	185	450		300	200+
t Norwich		Olean 50		300 (Upper 40 (Sub Olean 40 (Lower 220	180+	
ergeant*	120	160	325		260	(Upper 1,300 (Bradford 25 (Lower 309+
amlin	60	200		325 (Upper 50 (Sub Olean 40 (Lower 235	250	(Upper 1,265 (Bradford 65
letmore	22	170 (ss. 50 (Alton 15 (ss. 45 (Marsh- (burg 10 (cgl. 50	325		260	(Upper 1,313 (Bradford 70 (Lower 225

*Composite section

Two wells have been drilled to the Oriskany sand in McKean County and a number of wells have reached the Oriskany in the adjacent region. One well (Zerby) is now (May 1934) being drilled in McKean County, and two wells in Cameron County just south of the McKean line have reached a depth of 4,700 feet. The location of these wells is shown in Fig. 3 and pertinent data concerning them are listed below.



Of the wells shown, none have found gas in appreciable quantities except in Potter County. Here the Moran well located on the Smethport anticline yielded 8 million cubic feet a day initial and with it much salt water. The Emporium Lumber Company wells on Marshlands anticline had initial volumes of less than 100,000 cubic feet a day. The Hebron Field on Hebron anticline includes (May 1934) 17 wells having an average initial volume of 14 million cubic feet at about 2000 pounds rock pressure and an aggregate volume of more than 200 million cubic feet. Fragments of sand blown from these wells have an average porosity of about 9 per cent.

Of the dry holes shown, the Franke, Matteson, Kane, and Haywood did not find sand at the Oriskany horizon. Three other wells near the Matteson, all located on the southwest end of Hebron dome also failed to find sand. This is the only one of the instances cited where the absence of sand has been demonstrated by more than one well. The fact that Hebron Field is located on the same structure as these sandless wells illustrates the necessity for more than one well in condemning a structure on which the sand is not constant.

The thickness of the sand where encountered is as follows: Hebron Field 12 feet plus, Moe well 10 feet, Emporium Lumber well No. 1, 31 feet, Derrick City 20 feet, Quinlin 18 feet, Youngsville 10 feet, Tidioute 15 feet, Collins & Richards 8 feet.

The sand at Moe well is reported very fine, probably incapable; at Derrick City it carried a show of oil; Quinlin a show of oil and gas; Collins

& Richards a show of gas; Tidioute a show of salt water; and Youngsville dry; demonstrating that except at the Moe and Youngsville wells the sand is definitely a capable reservoir rock.

Some idea of drilling depth is afforded by an estimate of the interval between the base of the Catskill red beds and the Oriskany sand. At the Derrick City well this interval is 4,268 feet, at Kane well 4,700 feet, at Matteson well 5,123± feet, and at Emporium Lumber Company well No. 1, 5,689 feet. The interval appears, in general, to thin in a northwest direction. In southeast McKean County it probably exceeds 5,000 feet, and in the northwestern part of the county may not exceed 4,200 feet. In the central part of the county we might expect it to be something like 4,600 feet.

It is apparent from results at Matteson, Franke, Haywood and Kane wells that the Oriskany may be absent from an area in the southeast part of the county. This can be determined only by drilling. The Zerby and Emporium Bank wells will contribute to our information on this point.

Wells drilled to the Oriskany horizon*

Well Name	County	Elev.	Depth Orisk.	S.L. Elev.	Total depth	Results	Int. base red beds Oriskany
Moran°°	Potter	2087	4875	-2788	4879	8 mil. Salt water	
Nugent°°°	"	1869	4876	-3007	4887	16⅔ million	5100±
Franke	"	2260	5864	-3604	5881	Dry, no Oriskany	
Emporium Lumb. Co.***	"	1936	6280	-4344	6425	85,000	5689
Matteson**	"	2180	5174	-2994	5550	Dry, no Oriskany	5123±
Derrick City**	McKean	1576	4135	-2559	5760	Show of oil	4268
Haywood**	"	1748	5182	-3434	5269	Dry, no Oriskany	
Quinlin	N.Y. State	1686	4276	-2590	4295	Show of gas and oil	
Kane**	Elk	1836	5400	-3564	7930	Dry, no Oriskany	4703
Youngsville**	Warren	1208	3510	-2302		Dry	
Tidioute**	"	1642	4334	-2693	5818	Show salt water	
Collins & Richards**	Forest	1200	4527	-3327	5252	Show gas	

°°Rook pressure 1950

°°°Rock pressure 2160 Hebron Field

*For fuller information on deep wells in Pennsylvania and gas fields in Oriskany sand, see Pennsylvania Geol. Survey Bull. 106, Oil and Gas in Potter County, Pa., 1934; Bull. 107, Gas in Tioga County, 1934; Bull. 108, Geologic Structure in Plateaus Region of Northern Pennsylvania and its Relation to Occurrence of Gas in Oriskany sand, 1934.

**After C. R. Fettke.

***Courtesy of Allegheny Gas Co.